

DIGITAL WATERMARKING DEVICE, DIGITAL WATERMARK INSERTION  
METHOD AND DIGITAL WATERMARK DETECTION METHOD

BACKGROUNDS OF THE INVENTION

FIELD OF THE INVENTION

The present invention relates to a digital watermarking device, a digital watermark insertion method and a digital watermark detection method.

DESCRIPTION OF THE RELATED ART

Digital information can be easily reproduced, and is often copied illegally. Various digital watermarking technologies to insert digital watermark information into the digital information have been proposed so that the copyright holder can claim his/her copyright to the person who copied the information illegally. Devices and methods for digital watermark insertion into the digital information include, for example, the devices and the methods described in the Japanese Patent Application Laid-open (Kokai) No. 2000-59610 and No. 2000-59730.

Fig. 5 is a block diagram showing an configuration example of the device described in the Japanese Patent Application Laid-open (Kokai) No. 2000-59610. In this device, an image input section 540 fetches the image data as the original image. A square division section 550 divides the original image into squares. An information input section 560 inputs the predetermined information to be embedded in the image

data and an encoding section 520 embeds such information as the digital watermark information in the image data. Here, the encoding section 520 embeds the digital watermark information to every square (every block) divided. A control section 500 makes various controls. According to the device shown in Fig. 5, the digital watermark information is embedded to every piece of divided squares after division of the image data into squares, and the digital watermark information can be detected even when a part of the image data is cut off.

Fig. 6 shows an image stream to record the digital watermark information by the digital watermark information recording method as described in the Japanese Patent Application Laid-open (Kokai) No. 2000-59730. According to this recording method, the reference information to detect the digital watermark information is recorded in every frame containing the time information in the image stream. Here, the reference information is recorded so that it is contained in the encoded information obtained by encoding of the image. The position to record the reference information is uniquely specified by the time information. By this method, the reference information recording position varies frame by frame and the digital watermark information can be taken out by detecting the reference signal even when a part of the image information is masked.

5 Digital watermark information to be inserted into  
the image data includes, for example, the information  
about the owner of the image data and the information  
about whether or not to permit reproduction of the image  
data. When many types of digital watermark information  
are inserted to the image data, it will be difficult for  
a third party without authority for data utilization to  
analyze the digital watermark information. Therefore, to  
prevent analysis by a third party, it is preferable to  
10 insert as many types of information as possible for the  
digital watermark information.

Some types of inserted digital watermark  
information may deteriorate the image data. By inserting  
several types of digital watermark information,  
15 deterioration extent of the image data by a certain type  
of digital watermark information can be reduced. From  
this viewpoint, too, it is preferable to insert several  
types of information as the digital watermark  
information.

20 It is also preferable that the number of types of  
the digital watermark information to be inserted is  
highly flexible. Note that, however, the scale of the  
device for insertion and detection of the digital  
watermark is preferably small.

25 According to the device as described in the  
Japanese Patent Application Laid-open No. 2000-59610, an  
image is divided into sections and digital watermark

information is assigned to each section so that increased types of digital watermark information are inserted. However, because the digital watermark is embedded into the divided images, sufficient amount of digital watermark information cannot be embedded when the original image is not large enough over a certain size. In addition, when a divided section is lacking, the digital watermark information embedded to that section may not be obtained properly. The digital watermark information recording method as described in the Japanese Patent Application Laid-open No. 2000-59730 enables the digital watermark information to be taken out even when a part of the image information is masked, but it does not disclose a method to increase the types of digital watermark information to be recorded.

#### SUMMARY OF THE INVENTION

It is an object of the present invention to provide a digital watermarking device which inserts several types of digital watermark information into the digital information and detects the digital watermark information from the digital information with several types of digital watermark information inserted as well as to provide a digital watermark insertion method and a digital watermark detection method.

According to the first aspect of the invention, a digital watermarking device to insert the digital

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According to the digital watermarking device as  
5 described above, several types of digital watermark  
information can be inserted to the digital information  
containing the visual data and audio data.

In another preferred construction, the digital watermarking device further comprises a data separation circuit which separates the digital information into the visual data and the audio data, a time stamp detection circuit which detects and extracts the time stamp information from the visual data, and a data synthesis circuit which synthesizes the visual data and the audio data, wherein the digital watermark insertion circuit inserts the digital watermark information of the type uniquely specified corresponding to the time stamp information extracted from the visual data into the visual data separated by the data separation circuit, and the data synthesis circuit synthesizes the visual data containing the inserted digital watermark information and the audio data separated by the data

separation circuit.

According to the second aspect of the invention,  
a digital watermarking device to detect the digital  
watermark information from the digital information  
5 comprises

a digital watermark detection circuit which  
detects, from the digital information, the digital  
watermark information of the type uniquely specified  
corresponding to the data held by the digital  
10 information.

According to the digital watermarking device as  
described above, the digital watermark information can  
be checked while the visual and audio data in the  
digital information are played.

15 In the preferred construction, the digital  
watermark detection circuit detects the digital  
watermark information of the type uniquely specified  
corresponding to the time stamp information extracted  
from the visual data in the digital information from the  
20 visual data corresponding to the time stamps.

In another preferred construction, the digital  
watermarking device further comprises a data separation  
circuit which separates the digital information into the  
visual data and the audio data, a display signal  
25 generation circuit which prepares the display signal by  
synthesizing the visual data with the digital watermark  
information detected by the digital watermark detection

5 circuit, and an audio data conversion circuit which converts the audio data separated by the data separation circuit into the analog signal, wherein the digital watermark detection circuit detects the digital watermark information from the visual data separated by the data separation circuit.

10 In another preferred construction, the digital watermarking device further comprises a time stamp detection circuit which detects and extracts the time stamp information from the visual data in the digital information.

15 In another preferred construction, the digital watermarking device further comprises a data separation circuit which separates the digital information into the visual data and the audio data, a time stamp detection circuit which detects and extracts the time stamp information from the visual data in the digital information, a display signal generation circuit which prepares the display signal by synthesizing the visual  
20 data with the digital watermark information detected by the digital watermark detection circuit, and an audio data conversion circuit which converts the audio data separated by the data separation circuit into the analog signal, wherein the digital watermark detection circuit  
25 detects the digital watermark information of the type uniquely specified corresponding to the time stamp information extracted from the visual data in the



digital information from the visual data separated by the data separation circuit corresponding to the time stamps.

According to the third aspect of the invention, a  
5 digital watermarking device to insert the digital watermark information into the digital information comprises

a digital watermark insertion circuit which inserts the digital watermark information of the type  
10 uniquely specified corresponding to the data held by the digital information to the digital information, and

a digital watermark detection circuit which detects the digital watermark information of the type  
15 uniquely specified corresponding to the data held by the digital information from the digital information.

In the preferred construction, the digital watermark insertion circuit inserts the digital watermark information of the type uniquely specified  
20 corresponding to the time stamp information extracted from the visual data in the digital information to the visual data corresponding to the time stamps, and the digital watermark detection circuit detects the digital watermark information of the type uniquely specified  
25 corresponding to the time stamp information extracted from the visual data in the digital information from the visual data corresponding to the time stamps.

In another preferred construction, the digital

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watermarking device further comprises a data separation circuit which separates the digital information into the visual data and the audio data, a time stamp detection circuit which detects and extracts the time stamp information from the visual data, a data synthesis circuit which synthesizes the visual data and the audio data, a display signal generation circuit which prepares the display signal by synthesizing the visual data with the digital watermark information detected by the digital watermark detection circuit, and an audio data conversion circuit which converts the audio data separated by the data separation circuit into the analog signal, wherein the digital watermark insertion circuit inserts, to the visual data separated by the data separation circuit, the digital watermark information of the type uniquely specified corresponding to the time stamp information extracted from the visual data, the data synthesis circuit synthesizes the visual data containing the inserted digital watermark information and the audio data separated by the data separation circuit, and the digital watermark detection circuit detects, from the visual data separated by the data separation circuit corresponding to the time stamps, the digital watermark information of the type uniquely specified corresponding to the time stamp information extracted from the visual data in the digital information.

According to another aspect of the invention, a digital watermark insertion method to insert the digital watermark information into the digital information, wherein

5 inserting the digital watermark information of the type uniquely specified corresponding to the data held by the digital information to the digital information.

10 In the preferred construction, the digital watermark insertion method, wherein

extracting the time stamp information corresponding to the visual data in the digital information when the digital watermark information of the type uniquely specified corresponding to the data  
15 held by the digital information is inserted to the digital information, and inserting the digital watermark information of the type uniquely specified corresponding to the time stamp information to the visual data corresponding to the time stamps.

20 According to another aspect of the invention, a digital watermark detection method to detect the digital watermark information from the digital information, wherein

25 detecting the digital watermark information of the type uniquely specified corresponding to the data held by the digital information from the digital information.

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In the preferred construction, when the digital watermark information of the type uniquely specified corresponding to the data held by the digital information is detected from the digital information, extracting the time stamp information corresponding to the visual data in the digital information and detecting the digital watermark information of the type uniquely specified corresponding to the time stamp information from the visual data corresponding to the time stamps.

According to a further aspect of the invention, a computer readable memory to store the digital watermark insertion program which executes the digital watermark insertion processing to insert the digital watermark information to the digital information by controlling the computer, wherein

the digital watermark insertion program comprising the functions of

executing the processing to insert, to the digital information, the digital watermark information of the type uniquely specified corresponding to the data held by the digital information.

According to a still further aspect of the invention, a computer readable memory to store the digital watermark detection program which executes the digital watermark detection processing to detect the digital watermark information from the digital information by controlling the computer, wherein

the digital watermark detection program  
comprising the functions of

executing the processing to detect, from the  
digital information, the digital watermark information  
5 of the type uniquely specified corresponding to the data  
held by the digital information.

Other objects, features and advantages of the  
present invention will become clear from the detailed  
description given herebelow.

#### BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be understood more  
fully from the detailed description given herebelow and  
from the accompanying drawings of the preferred  
15 embodiment of the invention, which, however, should not  
be taken to be limitative to the invention, but are for  
explanation and understanding only.

In the drawings:

Fig. 1 is a block diagram to show an embodiment  
20 of a digital watermarking device according to the  
present invention;

Fig. 2 is an explanatory view to illustrate an  
example of visual data stream;

Fig. 3 is a block diagram to show another  
25 embodiment of the present invention;

Fig. 4 is a block diagram to show still another  
embodiment of the present invention;

Fig. 5 is a block diagram to show an example of the configuration of a conventional digital watermarking device; and

Fig. 6 is an explanatory view to illustrate the stream of data to which the digital watermark information is inserted according to the conventional method.

#### DESCRIPTION OF THE PREFERRED EMBODIMENT

The preferred embodiment of the present invention will be discussed hereinafter in detail with reference to the accompanying drawings. In the following description, numerous specific details are set forth in order to provide a thorough understanding of the present invention. It will be obvious, however, to those skilled in the art that the present invention may be practiced without these specific details. In other instance, well-known structures are not shown in detail in order to unnecessary obscure the present invention.

Fig. 1 is a block diagram showing an embodiment of a digital watermarking device according to the present invention. A file input circuit 10 inputs the visual/audio data file containing the synthesized visual and audio data. Here, the file input circuit 10 inputs the compressed visual/audio data file. A Demux circuit 20 separates the input visual/audio data into the visual data and the audio data. Fig. 2 shows an example of the

stream in the separated visual data. The visual data stream contains frames which consist of time stamps and compressed visual data. The separated audio data also has a similar stream.

5           A visual time stamp detection circuit 30 extracts the time stamps from the visual data. For detection of the digital watermark information, the visual time stamp detection circuit 30 outputs the time stamps and the visual data to a digital watermark detection circuit 40 and outputs the time stamps to an image decoding circuit 10 70. For insertion of the digital watermark information, the time stamps and the visual data are output to a digital watermark insertion circuit 80. The arrows shown in broken lines in the figure show the connections for 15 input and output of the time stamps.

          The digital watermark detection circuit 40 specifies the type of the digital watermark information to be detected corresponding to the time stamps and detects the specified digital watermark information from 20 the input visual data. The digital watermark detection circuit 40 outputs the detected digital watermark information to a result display circuit 50 and outputs the visual data to the image decoding circuit 70.

          Based on the digital watermark information input 25 from the digital watermark detection circuit 40, the result display circuit 50 prepares the display data for the information and outputs the display data for the

digital watermark information to an image output circuit  
60. The image decoding circuit 70 receives the  
compressed visual data from the digital watermark  
detection circuit 40 and restores such data, and outputs  
5 the visual data to the image output circuit 60 according  
to the times given by the time stamps input from the  
visual time stamp detection circuit 30.

The image output circuit 60 synthesizes the  
display data input from the result display circuit 50  
10 and the visual data input from the image decoding  
circuit 70 and prepares the display signal.

The digital watermark insertion circuit 80  
specifies the type of the digital watermark information  
to be inserted according to the time stamps, and inserts  
15 the specified digital watermark information to the input  
visual data. The digital watermark insertion circuit 80  
outputs the visual data with the digital watermark  
information inserted to a mixer circuit 90.

The mixer circuit 90 synthesizes the audio data  
20 input from an audio time stamp detection circuit 110 to  
be described later and the visual data input from the  
digital watermark insertion circuit 80. The file output  
circuit 100 stores the visual/audio data file  
synthesized by the mixer circuit 9.

25 The audio time stamp detection circuit 110  
extracts the time stamps from the audio data and, when  
detecting the digital watermark information, outputs the



time stamps and the audio data to an audio decoding circuit 120 and, when inserting the digital watermark information, outputs the audio data to the mixer circuit 90. The audio decoding circuit 120 restores the compressed audio data and outputs the data to an audio output circuit 130 according to the times indicated by the time stamps. The audio output circuit 130 converts the audio data restored by the audio decoding circuit 120 into the analog signal.

Next, the operation of the digital watermarking device having the above configuration will be described below.

Firstly, the operation when the visual/audio data without any digital watermark information inserted is input to the digital watermarking device, which inserts the digital watermark information to the data.

The visual/audio data without any digital watermark information inserted is input to the file input circuit 10, which outputs the data to the Demux circuit 20. Note that this data is compressed. The Demux circuit 20 separates the visual/audio data into the visual data and the audio data. Here, in the visual data stream as shown in Fig. 2, the visual data in each frame does not contain the digital watermark information. The Demux circuit 20 outputs the separated visual data and the audio data to the visual time stamp detection circuit 30 and the audio time stamp detection circuit

110 respectively.

The visual time stamp detection circuit 30 extracts the time stamp information from the visual data and outputs it to the digital watermark insertion  
5 circuit 80. In addition, the visual time stamp detection circuit 30 outputs the input visual data as it is to the digital watermark insertion circuit 80.

The digital watermark insertion circuit 80 uniquely specifies the type of the digital watermark  
10 information to be inserted corresponding to the input time stamp and inserts the digital watermark information of the applicable type to the visual data. For example, if the "Information about the owner of the visual/audio data file" is specified as the type of information to be  
15 inserted corresponding to a time stamp, the "Owner identification No." or the like will be inserted into the visual data corresponding to that time stamp. If the "Information about whether or not to permit reproduction of the visual/audio data file" is specified for a time  
20 stamp, the information "Reproducible" or "Not reproducible" or the like will be inserted.

The digital watermark insertion circuit 80 executes calculation using the time stamps and specifies  
25 the type of the digital watermark information according to the calculation results. For example, corresponding to the time stamp  $i$ , the digital watermark information circuit 80 calculates  $\alpha(i)$  as the remainder of the

formula  $(A * i + B)/C$  and specifies the type of the digital watermark information corresponding to  $\alpha(i)$ . Here, the digital watermark insertion circuit 80 associates the values of  $\alpha(i)$  and the types of the digital watermark information in advance and specifies the type corresponding to  $\alpha(i)$  as follows:

"Information about the owner" for  $\alpha(i) = 1$  and "Information whether or not to permit reproduction" for  $\alpha(i) = 2$ , for example. In this example, the value  $\alpha(i)$  is determined as the remainder of the division using  $C$ , the digital watermark information of  $C$  types can be specified by change of the time stamp  $i$ . The calculation of  $\alpha(i)$  here is just an example and other calculation methods may be used.

In addition, the digital watermark insertion circuit 80 stores the information to be inserted as various digital watermark information ("Owner ID No.", "Reproducible", "Not reproducible" and so on) in advance and inserts the information into the visual data corresponding to the specified type.

The digital watermark insertion circuit 80 outputs the visual data with the digital watermark information inserted to the mixer circuit 90.

Further, the audio time stamp detection circuit 110 outputs the audio data input from the Demux circuit 20 as it is to the mixer circuit 90.

The mixer circuit 90 synthesizes the visual data

with the digital watermark information inserted and the audio data and outputs the synthesized data to the file output circuit 100. The file output circuit 100 stores the data synthesized by the mixer circuit 90 as the visual/audio data file.

By thus inserting the digital watermark information, various types of digital watermark information corresponding to the time stamp *i* are inserted to the visual data in the stream. With several types of digital watermark information inserted, analysis of the digital watermark information by a third party can be prevented. In addition, even when a particular type of digital watermark information deteriorates the image data, insertion of several types of digital watermark information can reduce the extent of such deterioration.

Next, the operation when the visual/audio data with the digital watermark information inserted is input to the digital watermarking device, which detects the digital watermark information from such data will be described below.

The file input circuit 10 receives the input of the visual/audio data with the digital watermark information inserted and then outputs such data to the Demux circuit 20. Note that this data is compressed. The Demux circuit 20 separates the visual/audio data into the visual data and the audio data. Here, in the

visual data stream as shown in Fig. 2, the visual data in each frame contains the digital watermark information. The Demux circuit 20 outputs the separated visual data and the audio data to the visual time stamp detection circuit 30 and the audio time stamp detection circuit 110 respectively.

The visual time stamp detection circuit 30 extracts the time stamp information from the visual data and outputs it to the digital watermark detection circuit 40 and the image decoding circuit 70. In addition, the visual time stamp detection circuit 30 outputs the input visual data as it is to the digital watermark detection circuit 40.

The digital watermark detection circuit 40 specifies the type of the digital watermark information to be detected corresponding to the input time stamp and detects the digital watermark information of the applicable type from the visual data. For example, if the "Information about the owner of the visual/audio data file" is specified as the type of information to be detected, "Owner identification No." or the like will be detected from the visual data corresponding to the time stamp. If the "Information about whether or not to permit reproduction of the visual/audio data file" is specified for the time stamp, the information "Reproducible" or "Not reproducible" will be detected.

The digital watermark detection circuit 40

executes calculation similar to that executed in specification of the digital watermark information by the digital watermark insertion circuit 80, and thereby identifies the type of the information from the time stamp. Thus, if the digital watermark insertion circuit 80 inserts the "Information about the owner" into the visual data corresponding to a certain time stamp, the digital watermark detection circuit 40 will detect the "Information about the owner" from the visual data.

The digital watermark detection circuit 40 outputs the detection result of the digital watermark information (information types and the applicable information) to the result display circuit 50. For example, if the "Owner identification No." is detected as the "Information about the owner", the type "Information about the owner" and the detected identification No. will be output to the result display circuit 5. The result display circuit 50 converts the digital watermark information type and the information itself input from the digital watermark detection circuit 40 into display data to be displayed as characters and images and outputs such data to the image output circuit 60.

The digital watermark detection circuit 40 outputs the visual data to the image decoding circuit 70. The image decoding circuit 70 restores the compressed visual data input from the digital watermark detection

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the time stamps can be detected.

Since the digital watermarking device as shown in Fig. 1 uses the time stamps originally held by the visual/audio data to specify the types of the information to be inserted or detected, the scale of the device can be kept small. By changing the calculation method of  $\alpha$  (i) to associate the time stamps and the types of the digital watermark information, the number of digital watermark information types to be inserted or detected can be increased.

In the above embodiment, when the digital watermarking device inserts the digital watermark information into the visual/audio data without any digital watermark information inserted, the display signal may be prepared by the digital watermark detection circuit 40, the image decoding circuit 70 and the image output device 60. Further, the restored audio data may be converted into the analog signal by the audio decoding circuit 120 and the audio output circuit 130. With the display signal prepared and the audio data converted into the analog signal, visual/audio output from the display unit and the speaker or the like can be achieved at the same time as the insertion of the digital watermark information.

Though the "Information about the owner of the visual/audio data file" and the "Information about whether or not to permit reproduction of the



visual/audio data file" are shown as examples of the digital watermark information types in the above embodiment, the types of the digital watermark information are not limited to them.

5           Next, a digital watermarking device according to another embodiment of the present invention will be described below.

10           Figs. 3 and 4 show block diagrams showing other embodiments of the present invention. The digital watermarking device as shown in Fig. 3 is a device to insert the digital watermark information into the visual/audio data without any digital watermark information inserted. However, it does not detect any digital watermark information from the visual/audio data  
15           with the digital watermark information inserted. The circuits of the digital watermarking device as shown in Fig. 3 are similar to the corresponding circuits shown in Fig. 1. Therefore, the operation to insert the digital watermark information to the visual/audio data  
20           is the same as that by the digital watermarking device according to the first embodiment above shown in Fig. 1. Note that, however, the digital watermarking device in this embodiment is not provided with an image decoding circuit 70, an audio decoding circuit 120 and so on and  
25           does not output visual/audio data from the display unit and the speaker or the like with inserting the digital watermark information.

The digital watermark insertion method and the digital watermark detection method in the digital watermarking device according to the present invention can be realized by achieving the functions of the digital watermarking device with hardware, of course, and also by loading a computer program having the applicable functions (digital watermark insertion

program) to the memory of the computer processor. The digital watermark insertion program can be stored in a magnetic disk, semiconductor memory or other recording medium (reference No.). Such program is loaded to the computer processor from the recording medium and controls the operation of the computer processor to achieve the functions as described above.

According to the digital watermarking device and the digital watermark insertion method of the present invention, the digital watermark information of the type uniquely specified corresponding to the data held by the digital information into the digital information. Thus, several types of digital watermark information can be inserted corresponding to the data in the digital information and thereby analysis of the digital watermark information by a third party can be prevented. Further, the image deterioration which may be caused by a particular type of digital watermark information can be reduced.

Further, according to the digital watermarking device and the digital watermark detection method of the present invention, the digital watermark information of the types uniquely specified according to the data held by the digital information is detected from the digital information. Thus, several types of the digital watermark information inserted can be detected.

Although the invention has been illustrated and

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